Implementation of the Critical Thinking Strategies in the School Subject Technology: A Preliminary Study

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Abstract **– The theoretical starting points of this treatise are based on the repeating demands coming from real practice regarding improvement of critical thinking of pupils at primary schools in the Slovak Republic. The question is – to what extent is the topic of critical thinking being introduced and implemented in the educational process by our teachers? The answer to this and also many other questions was explored via research that was carried out within the frame of APVV-15-0368 project called Practical Training in the Centre of Field Didactics, the Field Didactics in the Centre of Practical Training. The main goal of this treatise is to present the research outcomes regarding implementation of the critical thinking strategies within the subject Technology at primary schools in the Slovak Republic. Teachers have stated that the biggest importance is generally ascribed to the deployment of various teaching aids, acquisition of practical skills and frequent contact with technical materials and tools.**

Keywords **– teaching strategies, critical thinking, technology, education.**

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1. Introduction

The term critical thinking started to be used more frequently in pedagogical theory at the turn of 20th and 21st century. From that time, many definitions of critical thinking have been created. The issue of critical thinking was discussed by many philosophers, psychologists and pedagogues what can be seen in the following definitions:

- Critical thinking is a way of meaningful and purposeful thinking that is aimed to formulate a judgement, while the thinking itself fulfils the standards of adequacy and accuracy [1];
- Critical thinking is a set of mental processes and strategies that are used by people to solve problems, to make decisions and to learn new concepts [2];
- Critical thinking or pondering is an intellectual process that is based on the understanding of term, analysis, synthesis and evaluation of information [3].

Improvement of critical thinking is conditioned by several factors that we should keep in mind when trying to reach particular goal. Probably the most important role in the process of improvement of critical thinking belongs to a teacher who must deploy strategies of critical thinking according to the particular aim and the contents of educational process while respecting all the principles and rules for improvement of critical thinking [4].
Fundamental principles of critical thinking are expressed in Figure 1.

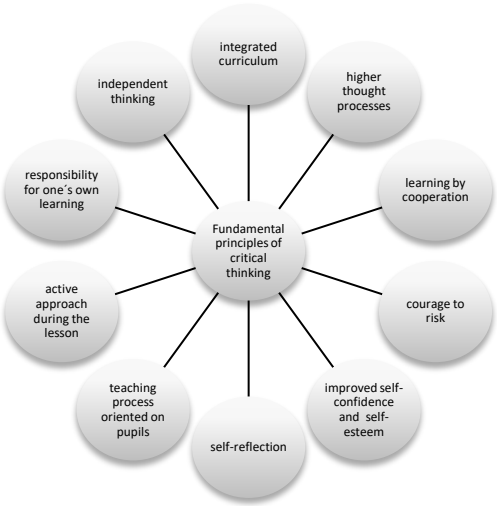

Figure 1. Fundamental principles of critical thinking [5]

The fundamental principles of critical thinking are:

- Long-term effective teaching that is applicable to the new situations when pupils actively participate in educational process plus they obtain and systematise information;
- Learning is more effective when it uses several thought strategies;
- Learning is more intensive when pupils have a possibility to apply new information in authentic tasks;
- Learning escalates when it is based on previous knowledge or experience;
- Critical thinking occurs in situations, where there is no convergent thinking;
- Learning is better in such environment, where the relationship between teacher and pupil is based on mutual respect;
- Teaching is the best in those classes, where the socio-moral atmosphere is based on mutual respect and understanding [5].

Besides the set of complex activities for pupils, usage of advanced technologies and importance of both individual and team work in learning, the emphasis is also put on the improvement of critical thinking in the current State Education Programme of the Slovak Republic for the school subject Technology at the level of lower secondary education [6]. Critical thinking occupies the leading position not only in the field of general educational goals, but also in the field of key competencies in the frame of lifelong learning. Leading pupils towards deployment of critical thinking is one of the prerequisites in the process of reaching the ideal model of education within Milénium project, what was later declared in the State Education Programme [7].

2. Background of the study

Technology is a compulsory school subject taught in Slovakia at the lower level of secondary education (ISCED 2, in Slovak conditions grades 5 – 9 of a basic school) with a time allocation of 1 lesson per week in each of the grades 6 – 9). According to the State Education Program [6] the purpose of the school subject is to form practical work habits of students, i.e. to complete their general education with a component necessary for one´s integration into the real practical life and the labour market, too. Through practice oriented activities students acquire safe work habits and learn to assess risk when working with various materials and tools. Furthermore, students acquire basic administrative and commercial skills such as time and resource management.

The main objectives of education in this subject is the development of:

- technical creativity, which [8] defines as the activity of students related to technology, characterized by the full concentration of students on the technological object of education;
- technological literacy includes basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently [9].
- technical thinking (complex of thought operations, particularly the thought analysis of the work result expectations, retaining and activating previously acquired knowledge, skills and experiences, which may be used to solve a particular given problem, in construction, production process, and the synthesis of all the matters by means of which the solver reaches the project design, in other words the construction solution and processing of a product [10];
- spatial imagination, i.e. the ability to imagine/visualise features of three-dimensional objects – their shape, position, size, location [11];
- knowledge and skills related to technology, technical materials and tools for their processing.

3. Methodology

The main goal within APVV project is oriented on the identification of adaptive teaching strategies that use cognitively oriented approach for improvement of critical and creative thinking of pupils and other

key psycho-didactic topics and strategies in particular fields of vocational didactics and their implementation in undergraduate practical preparation of teachers at the level of secondary education via Centre of Excellence for practical training [12]. Keeping the abovementioned main project goal in mind, we formulated the main goal of our research that is to find out the ratio of deployment of strategies of critical thinking in technically oriented school subjects.

Partial goals:

1. To detect the importance and frequency of implementation of particular strategies by teachers.
2. To detect the importance and frequency of implementation of particular strategies by students.
3. To verify the reflection of cooperation between a teacher and a specialist in didactics field.
4. To find out the rate of implementation of strategies by a practice teacher and the self-reflection of a student.
5. To verify reflection of cooperation between a student and a practice teacher.
6. To verify reflection of cooperation between a student and a specialist in didactics field.

In this treatise we focused our attention on verification of one partial goal - to detect the importance and frequency of implementation of particular strategies by teachers. The main verification tool for detection of importance and frequency of deployment of particular teaching strategies was a questionnaire. We had 211 respondents (teachers of technically oriented subjects at primary and secondary schools) that participated in our research, what is quite high number of a sample when considering the contemporary inauspicious situation in technical education that has been caused by a series of not very successful school reforms. The current negative situation can be confirmed by the fact that only some schools were able to put the innovated lessons of Technology back into their school education programmes. The questionnaire contained 25 closed questions with a simple choice of answer, two open questions offered a possibility to freely express one`s own answer. All the questions focused on the identification of both general and specific strategies for technically oriented school subjects and were divided into these three groups:

a) implementation of strategies according to B.S. Bloom taxonomy,
b) implementation of general strategies of critical and creative thinking,
c) implementation of technically oriented strategies.

In the next part of this contribution we deal with the evaluation of the third part – implementation of technically oriented strategies.

4. Results

Verification of implementation of technically oriented strategies was carried out via those questions in which we asked teachers whether during the lessons they create situations where pupils can:

- obtain the basic user skills,
- work with various sources of teaching aids,
- execute practical activities with technical materials and tools,
- design and execute particular assemble or production procedures,
- experiment with ideas, materials, technologies and techniques,
- work in small groups during practical activities,
- develop their responsibility for the quality of their work,
- be informed about changes and demands of labour market.

In the process of creating those questions, we were taking into account all the principles of critical thinking improvement and curriculum standards for the school subject Technology. Our participants could express the frequency of implementation of particular strategy on a six grade scale, where 6-5 referred to implementation in every lesson, 4-3 not in every lesson and 2-1 for no implementation of such strategies. They also had a possibility to express importance of deployment of the strategies, where 6-5 were considered to be extremely important, 4-3 for not very important and 2-1 for unimportant ones. The outcomes of teachers´ self-reflection in figure 2 show that technically oriented strategies of critical thinking in technical subjects are widely used by participating teachers who marked numbers 6 and 5 on the scale.

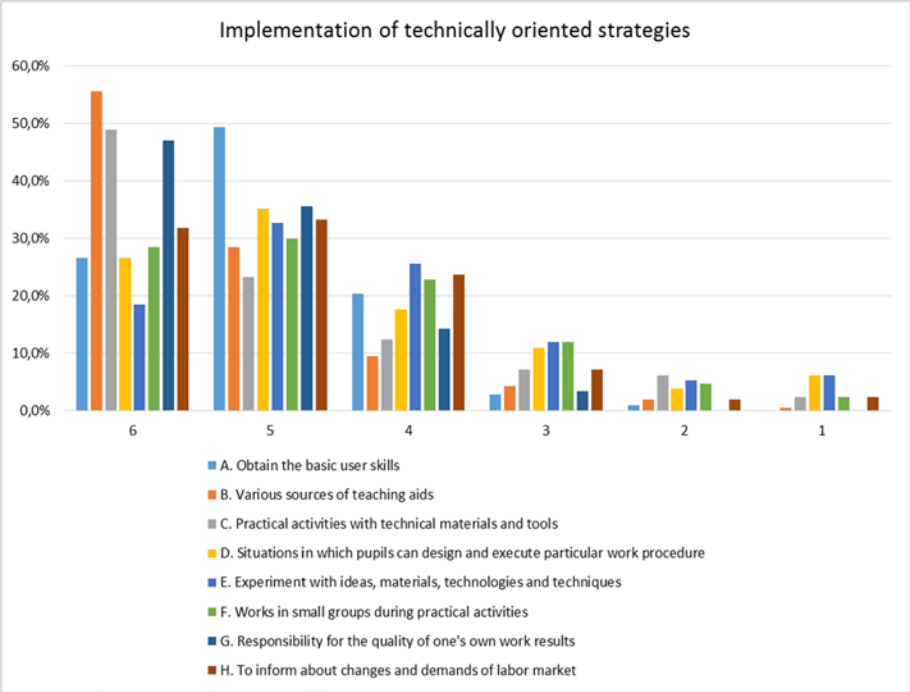

Figure 2. Implementation of technically oriented strategies of critical thinking

The abovementioned findings have been confirmed also by teachers participating in the project Škola, ktorej to myslí (Smart School). According to their opinions, methods of critical thinking have become popular among pupils who like working in groups, they learn how to cooperate, communicate at adequate level and react quickly when dealing with particular problem or issue. Also cooperation between school and families, mutual cooperation of pupils and presentation of pupils´ projects have been improved according to the opinions of teachers [13].

Deployment of various sources of teaching aids is the most widely used strategy (84%) within the subject Technology. It is followed by leading pupils towards responsibility for the quality of their work (82 %) and acquisition of basic user skills (almost 76%). Next in order is an execution of practical activities with technical materials and tools (72%) and a possibility to design and execute particular assemble or production procedures (almost 62%). When taking the demands of State Education Programme into consideration, we positively perceive that teachers plan to use the mentioned practical activities, but from the point of view of complex development of pupils´ personality, it is also needed to take account of the other specific goals in the frame of this school subject.

In the innovated concept of technical education, besides other items, there is an exploratory oriented approach in teaching being emphasized. It is supposed that teachers will create situations that support observation, exploration, measurements, deduction, searching for answers and experimenting - that all participate in the overall improvement of critical thinking. So, the next part of our questionnaire was oriented on the ratio, at which the teachers of technical subjects use the abovementioned forms for improvement of critical thinking. When looking at their answers, we can see that 51% of them use the experimentation in every lesson (6-5 points at the scale), sometimes 37% (4-3 points) and never 11% (2-1 points). We suppose that implementation of this strategy could have been even higher, but the liquidation of school workshops plus reduction in time allocation for school subject Technology in recent years caused that these strategies and activities cannot be carried out at schools nowadays. Another fact is that many teachers have not fully understood the main intention of the reform, as it was mentioned in a recent research oriented on the content orientation of the subject Technology [14].

When looking at the results of verification of strategies of critical thinking, we can deduce that at the highest positions of our scale (6 and 5 points) 58% of teachers stated that they create an environment where pupils can work in small groups when working and 65% of teachers stated that they regularly inform their pupils about the news and development in the field of technologies and the current demands of labour market. Only a little percentage of teachers (at level of 3-1) stated that they used the mentioned strategies just rarely or they did not use them at all, what can be ascribed to the current situation in teaching technically oriented subjects in Slovakia. Unfortunately, it seems that some of those teachers have forgotten what the fundamental substance of this school subject lies in. As if they do not consider it to be an ideal place to

get familiar with new technologies or to build and strengthen future professional orientation of pupils, they only connect importance of this subject with a development of practical skills of pupils [15]. The abovementioned facts have been confirmed by the obtained outcomes from the second part of our questionnaire, in which we detected how teachers perceive the importance of particular strategies.

Teachers´ answers show (Fig. 3.) that deployment of various sources of teaching aids is considered to be very important (6-5 points at the scale) by 82 % of them. 81% of teachers put an emphasis on practical activities with technical materials and tools. This indicates that those teachers really do not consider the school subject Technology to be the place which can help improve pupils` critical, creative or technical thinking. They connect Technology especially with development of practical skills what leads to extremely narrowed point of view at this school subject.

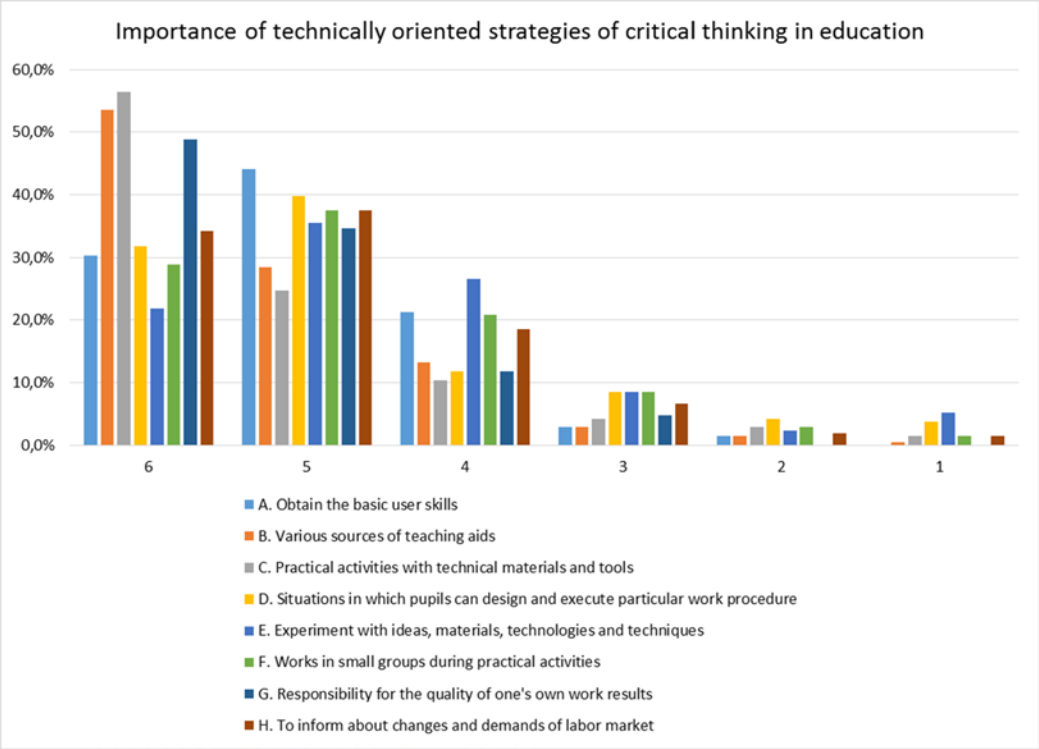

Figure 3. Importance of technically oriented strategies of critical thinking in education

It is confirmed also by another fact, that 74% of teachers (6-5 points at the scale) think that also acquisition of fundamental user skills is very important. By comparing outcomes in Figures 1. and 2. we can deduce that the importance that is ascribed to particular strategies by teachers is proportional to the frequency of their deployment in teaching process in technically oriented subjects. The fact that teachers ascribe the biggest importance to practical skills is confirmed also by the abovementioned research that was focused on a content orientation and teaching trends in the subject Technology [14].

The outcomes of this research show that the common requirement of teachers is to deepen the practical character of a lesson and to be more oriented on improvement of practical skills of pupils, even to the detriment of their theoretical knowledge [14]. Authors of the research state that in the frame of discussion about the issues regarding ideal situation in teaching the school subject Technology, the teachers did not deal with the question of content orientation within this subject, they only discussed the matter how to provide practical forms of teaching.

Non proportional relation between the importance and real deployment of particular strategies can be seen on scale 5 within these strategies: design and execution of particular assemble or production procedures, work in small groups during practical activities, experiments with ideas, materials, technologies and techniques and awareness about changes and demands in the environment of labour market. The self-reflective evaluation of teachers shows that higher importance is ascribed to the

abovementioned strategies at the expense of frequency of their deployment. Opinions of 16% of teachers can be considered to be extremely significant, who on scale 2-1 (the least important part of the scale) marked the situations in which pupils can design and execute particular assemble or production procedures and experiment with ideas and 12 % of teachers think that the least important is the work in small groups.

The abovementioned negative changes could have been reflected not only in the teaching process, but also in thinking of some pedagogues. Unfortunately, in some findings can be reflected opinions of non-qualified teachers who just teach that subject as replacement for erudite and qualified teacher of Technology, but also opinions of such teachers whose level of critical thinking is simply insufficient. The outcomes of mapping the level of critical thinking of teachers at secondary schools in 2011-2012 show that the critical thinking of these teachers is at average (standard) level [6]. The main reason of this situation is a traditional character of teaching profession, what goes hand in hand with traditional way of teaching. This fact was confirmed also by Williams [16], who warns that one of the most dominant obstacles blocking the achievement of cognitive and metacognitive development of pupils is the limited knowledge of teachers in the field of support for critical thinking.

The mentioned school reform that brought reduction of time allocation for technically oriented school subjects led to the logical consequence – increase in number of non-qualified teachers or the teachers who did not graduate in required teaching specialization [17]. This was confirmed by recent researches oriented on mapping the situation regarding the overall numbers of qualified teachers for the school subject Technology which showed that there were 34% of non-qualified teachers at Slovak schools in 2015 [18] and 30% of such teachers in 2016 [19].

5. Conclusion

Nowadays, it does not pose a big problem to get sufficient amount of information about critical thinking, however, when looking at everyday practice, it seems to be obvious that teachers are not well prepared to face this challenge – to implement strategies of critical thinking in the teaching process.

This was confirmed also by several recent researches in this field that were carried out on the territory of Slovakia [20, 7]. The mentioned facts can be confirmed also by the outcome analysis of partial goal 1 - *To detect the importance and frequency of implementation of particular technically oriented strategies by teachers* that was verified by our research team. The biggest importance is ascribed to the strategies that are based on deployment of various teaching aids, those in which pupils can obtain specific technical skills and where they can work with technical materials and tools.

We can observe almost perfect balance between the implementation of particular strategies in practice and the importance that teachers ascribe to those strategies. Obtained results present the self-reflection of just teachers themselves. Further research is needed, if we want to get more objective evaluation of the mentioned strategies. Therefore, our next partial goal is the evaluation of the strategies implemented by teachers from the point of view of students.

Many experienced teachers confirm the fact that improvement of critical thinking is possible, if not only teaching strategies supporting improvement of critical thinking are applied in educational process, but also specific strategies resulting from the content requirements of particular school subject are taken into consideration. We have designed a set of following requirements regarding improvement of critical thinking in the environment of practical training, while taking into consideration both the abovementioned reasons and the processed research outcomes:

- to improve the quality of undergraduate preparation of students – future teachers of technically oriented subjects;
- to support independence of thinking and self-reliance in educational process;
- to develop ability of both constructive and critical analysis of practical activities;
- and the last, but not the least, to implement research-oriented approach in learning.

The research-oriented approach nowadays belongs to the relatively new approaches that enable and support the application of methods of critical thinking not only in the field of technical education that uses elements of natural and spontaneous learning of pupils. This approach deploys the implementation of strategies of critical and creative thinking that are based on active observation, measurements and evaluation of obtained data [21]. It can be considered to be important not only in relation to the fulfilment of specific goals within the subject Technology, but also in relation to the desired ideals in education that can be reached, besides other things, thanks to the creative and critical thinking.

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